SECTION 7.10 - SJV

UNPAVED ROAD DUST

(non-farm roads, SJV only)

(Updated May 2004)

EMISSION INVENTORY SOURCE CATEGORY
Miscellaneous Processes / Road Dust

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION

645-638-5400-0000 (47399) Unpaved Road Travel Dust - City & County Roads
645-640-5400-0000 (47407) Unpaved Road Travel Dust - U.S. Forests & Park Roads
645-644-5400-0000 (47423) Unpaved Road Travel Dust - BLM/BIA Roads

DESCRIPTION OF SOURCE

This source category provides estimates of the entrained geologic particulate matter emissions that result from vehicular travel over non-agricultural unpaved roads in the San Joaquin Valley Unified Air Pollution Control District (SJVU APCD). This update was developed specifically for the SJV PM10 SIP for 2003. The emissions are estimated separately for three major unpaved road categories: city and county roads, U.S. forests and park roads, and Bureau of Land Management (BLM) and Bureau of Indian Affairs (BIA) roads. The emissions result from the mechanical disturbance of the roadway and the vehicle generated air turbulence effects. The updated particulate matter estimates for unpaved roads in the SJV are summarized in Table 1.

OVERVIEW OF ESTIMATION METHODOLOGY

Dust emissions from unpaved road dust are based on an emission factor that provides an approximation of the pounds of PM10 generated per vehicle mile traveled on an unpaved road. The current emission factor used by the ARB is 2.0 lbs PM_{10}/VMT (vehicle mile traveled). This factor is based on measurements of unpaved road dust emissions performed in separate projects by the University of California, Davis (UCD)[1] and the Desert Research Institute (DRI)[2]. The miles of unpaved City and County roads was provided by the SJV county local transportation agencies (TPAs)[3]. The mileage for other roads is based on historical data from Caltrans[4]. To compute the VMT data, it is currently assumed that each mile of unpaved road in the SJV receives ten vehicle passes each day.

EMISSIONS ESTIMATION METHODOLOGY

Emission Factor. The emission factor used for the estimates of geologic dust emissions from vehicular travel on unpaved roads is based on work performed by UC Davis[1], and the Desert Research Institute[2]. The emission factor used for all unpaved roads statewide is 2.0 lbs PM_{10}/VMT. The emission factor is based on the

average of 22 unpaved road dust emissions tests performed in the San Joaquin Valley for light-duty truck traffic. Because the emission measurements were performed in California, this emission factor was used to replace the previous generic emission factor provided in U.S. EPA's AP-42 document[5]. The new emission factor is slightly lower than the emission factors derived with the AP-42 methodology.

This methodology directly computes PM_{10} emissions. Using ARB's size speciation profiles, the TSP emissions are PM_{10} x 1.64[6].

Rainfall Correction. The most recent version of EPA's AP-42[5], includes a rainfall correction factor for the unpaved road dust emissions. Because the tests used to calculate the ARB unpaved road dust emission factor do not include rainfall corrections, we adopted the EPA methodology for this purpose. The rainfall correction zeros out the unpaved road dust emissions on days in which there is measurable rainfall. On an annual basis, the rainfall correction factor equation is: $EF_{rain} = EF\ [(365-P)/365]$, where P equals the number of days in a year with over 0.01 inches of precipitation.

For our estimates, we used monthly precipitation data for each county in the SJV to adjust the default emission estimates. This helped provide localized estimates as well as providing a monthly profile of unpaved road dust emissions.

Activity Data. To estimate the unpaved road dust PM10 emissions, is assumed that the emissions are related to the vehicle miles traveled (VMT) on the roads. Using data from the Caltrans, "Assembly of Statistical Reports"[6], the unpaved road mileage for roads under the jurisdiction of the USFS, BIA, and BLM were estimated for 1993. These road mileages were grown to 1999 values for the SJV SIP using a combination of population and forestry employment data. For city and county roads, the local Transportation Planning Agencies[4] were able to directly provide current road mileage estimates for 1999.

It was then assumed that 10 daily VMT (DVMT) are traveled on unpaved city and county roads. This is based on 1976 and 1979 ARB staff surveys of several county traffic engineers. For U.S. forest and parks roads, it is also assumed that 10 DVMT are also traveled per mile of road. This is based on a discussion with a member of the United States Forest Service in 1986[7]. Because of the potential similarity in the types of traffic, it is also assumed that the BLM and BIA also receive 10 DVMT.

Table 1 summarizes the mileage and VMT activity data for each road grouping and county in the SJV. The grown 1999 data are also shown for the non-city/county roads, as well as the effect of the rainfall correction factor.

TEMPORAL ACTIVITY AND GROWTH

Daily activity on unpaved roads occurs primarily during daylight hours. Activity is assumed to be the same each day of the week. Monthly activity varies by county and for this methodology it is based on estimates of monthly rainfall in each county.

This reflects that during wet months there is less unpaved road traffic, and there are also lower emissions per mile of road when the road soils have a higher moisture content. Table 2 shows the unpaved road dust temporal profile for each county in the SJV.

Unpaved road growth is associated with on-road vehicle VMT for city and county unpaved roads, and population and forestry employment for the other roads.

ASSUMPTIONS AND LIMITATIONS

1. This methodology assumes that all unpaved roads in California emit the same levels of PM_{10} per VMT for all vehicles, locations, and conditions. However, some adjustment is made to the emission estimates to reflect rainfall conditions.
2. It is assumed that all unpaved roads in the SJV (and California) receive 10 vehicle passes per day.
3. This methodology assumes that no controls are used on the roads included in this inventory.
4. This methodology does not include private unpaved roads or agricultural unpaved roads. They are calculated in separate methodologies.

CHANGES IN THE METHODOLOGY

There were three methodology changes for this unpaved road dust update for the SJV. First, the prior emission factor of 2.3 lbs PM10/VMT was changed to 2.0 lbs PM10/VMT to reflect the most recent test data. Second, the unpaved road mileage for city and county roads is now based on estimates by the local TPAs, rather than historical Caltrans data. And finally, a rainfall correction factor was included which reduces the emissions on rainy days and was used to generate the monthly seasonal profiles of unpaved road dust emissions.

COMMENTS AND RECOMMENDATIONS

Virtually everything in this category could use improvement. Although expensive to develop, more region and season specific emission factors would help to improve the accuracy of the unpaved road dust particulate matter inventory. The VMT activity data is also very crude, and probably does not clearly represent the actual volume of unpaved road travel.

Caltrans also no longer estimates unpaved road mileage, so determining the current mileage requires forecasting mileage from past estimates, which has significant uncertainties. Fortunately, for the city and county roads, the local Transportation Planning Agencies were able to provide current unpaved road mileage data.

SAMPLE CALCULATIONS

The instructions and associated table below provide an example of computing baseline unpaved road dust emissions. For the SJV, these emissions are then grown, and corrected for the effects of rainfall. Unfortunately, the full method is too complex to easily display, so please contact the ARB for the detailed calculation spreadsheet if needed[8].

Step 1: Road Miles. Input the miles of unpaved road for each category.

Step 2: Passes per Day. Input the estimated vehicle passes per day for each road type. The current California default is 10.

Step 3: Vehicle Miles Traveled (VMT). Compute the annual vehicle miles traveled for each road type. This is: *Road Miles x Passes/Day x Days/Year* (i.e., *Step 1 x Step 2 x 365*), which, using the ARB default values is *Road Miles x 3650*.

Step 4: Emission Factor. Input the roadway emission factor. The default ARB emission factor for unpaved roads is 2.0 lbs PM_{10}/VMT.

Step 5: Compute Emissions. Multiply the vehicle miles traveled estimate (Step 3) by the emission factor (Step 4), and divide by 2000 lbs/ton to compute the annual road specific PM_{10} emissions. *(VMT x Emission Factor)/2000 = Annual Emissions*.

Step 6: Total Emissions. Sum emissions for the unpaved roads to compute the total unpaved road emissions.

Note: For the SJV

Estimating Unpaved Road Dust
PM_{10} Emissions

		Road Type			
		City & County	U.S. Forest & Parks	BLM & BIA	Total
Step 1	Miles of Road	372	233	292	897
Step 2	Passes/Day	10	10	10	10
Step 3	VMT/year	1,357,800	850,450	1,065,900	3,274,050
Step 4	Emission Factor *(lbs PM_{10}/mile)*	2.0	2.0	2.0	2.0
Step 5	Emissions *(tons PM_{10}/year)*	1358	850	1065	3273

References

1. Flocchini, Robert; et al. Evaluation of the Emission of PM_{10} Particulates from Unpaved Roads in the San Joaquin Valley, Final Report. University of California, Davis. Air Quality Group, Crocker Nuclear Laboratory. San Joaquin Valley Grant File #20960. April, 1994.

2. Gillies, John; et al. Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders on Paved Roads, Final Report. Desert Research Institute. DRI Document No. 68505200.1F1, for the California Regional Particulate Air Quality Study. December 1996.

3. Anderson, Cari. Earth Matters, Consultant to the SJV District Transportation Planning Agencies. Spreadsheet provided to the ARB via email November 2, 2002, "Revised SJV Unpaved Road Mileage."

4. California Department of Transportation. Assembly of Statistical Reports, 1992, and Assembly of Statistical Reports, 1993. California Public Road Data Including Highway Performance Monitoring System (HPMS) Data. February 1994 and January 1995.

5. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 13.2.2, Fifth Edition. December 2003. http://www.epa.gov/ttn/chief/ap42/ch13/

6. Houck, J.E., Chow, J.C., Watson, J.G., et al. Determination of Particle Size Distribution and Chemical Composition of Particulate Matter from Selected Sources in California, Final Report. Desert Research Institute & OMNI Environmental. Prepared for California Air Resources Board. Agreement No. A6-175-32. June 30, 1989.

7. Watkins, Greg. USDA, Forest Service, San Francisco, CA, personal communication, 1986.

8. Gaffney, Patrick. California Air Resources Board. Spreadsheet used for San Joaquin Valley Unified Air Pollution Control District PM10 SIP, 2003. Spreadsheet, "Unpaved1999Mar_13_2003Final.xls"

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Table 1. 1999 SJV Unpaved Road Dust Emissions.

		Miles	Vehicle Passes per Day	VMT (1000/year)	VMT plus Growth* (1000/year)	Original Emissions (PM10 tpy)	Original Emissions plus Growth* (PM10 tpy)	Rain Adj. Emissions (PM10 tpy)
Fresno	**City/County**	100.5	10	366.6	366.6	366.6	366.6	326.7
	BLM/BIA	153.4	10	560.0	620.9	560.0	620.9	553.2
	USFS/Parks	509.5	10	1859.7	2061.7	1859.7	2061.7	1836.9
	Totals (1999)	**763.4**		**2,786**	**3,049**	**2786**	**3049**	**2717**
Kern	**City/County**	74.0	10	270.1	270.1	270.1	270.1	243
	BLM/BIA	429.4	10	1567.3	1749.2	1567.3	1749.2	1573
	USFS/Parks	54.9	10	200.4	223.6	200.4	223.6	201
	Totals (1999)	**558.3**		**2,038**	**2,243**	**2038**	**2243**	**2017**
Kings	**City/County**	70.1	10	255.9	255.9	255.9	255.9	229
	BLM/BIA	0.3	10	1.1	1.2	1.1	1.2	1
	USFS/Parks	0.0	10	0.0	0.0	0.0	0.0	0
	Totals (1999)	**70.4**		**257**		**257**	**257**	**230**
Madera	**City/County**	87.0	10	317.6	317.6	317.6	317.6	280
	BLM/BIA	0.0	10	0.0	0.0	0.0	0.0	0
	USFS/Parks	91.5	10	333.9	403.8	333.9	403.8	356
	Totals (1999)	**178.5**		**651**	**721**	**651**	**721**	**636**
Merced	**City/County**	222.0	10	810.3	810.3	810.3	810.3	697
	BLM/BIA	0.0	10	0.0	0.0	0.0	0.0	0
	USFS/Parks	35.8	10	130.8	139.5	130.8	139.5	120
	Totals (1999)	**257.8**		**941**	**950**	**941**	**950**	**817**
San Joaquin	**City/County**	20.0	10	73.0	73.0	73.0	73.0	62
	BLM/BIA	0.0	10	0.0	0.0	0.0	0.0	0
	USFS/Parks	14.2	10	51.7	57.7	51.7	57.7	49
	Totals (1999)	**34.2**		**125**	**131**	**125**	**131**	**111**
Stanislaus	**City/County**	47.0	10	171.6	171.6	171.6	171.6	149
	BLM/BIA	0.0	10	0.0	0.0	0.0	0.0	0
	USFS/Parks	0.5	10	1.8	2.0	1.8	2.0	2
	Totals (1999)	**47.5**		**173**	**174**	**173**	**174**	**150**
Tulare	**City/County**	128.6	10	469.4	469.4	469.4	469.4	414
	BLM/BIA	45.0	10	164.3	180.8	164.3	180.8	160
	USFS/Parks	74.3	10	271.1	298.3	271.1	298.3	263
	Totals (1999)	**247.9**		**905**	**948**	**905**	**948**	**837**

SJV Emissions Summary	**Miles**	**Vehicle Passes per Day**	**VMT** (1000/year)	**VMT plus Growth*** (1000/year)	**Original Emissions** (PM10 tpy)	**Grown Emissions*** (PM10 tpy)	**Rain Adj. Emissions** (PM10 tpy)
City/County	**749**	**10**	**2734**	**2734**	**2734**	**2734**	**2401**
BLM/BIA	**628**	**10**	**2293**	**2552**	**2293**	**2552**	**2287**
USFS/Parks	**781**	**10**	**2849**	**3187**	**2849**	**3187**	**2828**
Total 1999 New	**2158**	**10**	**7876**	**8216**	**7876**	**8473**	**7516**

* Only applies to BLM/BIA and USFS/Parks roads. Grown from 1993 base year miles. City/County miles not grown because 1999 mileage estimates were provided by TPAs.

PM Fraction: PM_{10} = TSP x 0.5943 (TSP Emissions = PM_{10}/0.5943)

Table 2
Seasonal Profile for SJV Unpaved Road Dust Emissions

Basin	Co #	County	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SJV	10	FRESNO	7.26	6.58	7.50	8.12	8.98	9.10	9.53	9.53	8.92	8.92	7.81	7.75
	15	KERN	7.25	6.52	7.62	7.92	8.90	9.14	9.45	9.45	8.84	9.02	7.98	7.92
	16	KINGS	7.34	6.57	7.65	7.95	8.87	9.17	9.48	9.48	8.87	8.87	7.95	7.80
	20	MADERA	7.14	6.52	7.45	8.07	9.01	9.01	9.63	9.63	9.01	9.01	7.76	7.76
	24	MERCED	6.61	6.37	7.48	8.20	9.24	9.32	9.87	9.87	9.24	9.08	7.64	7.09
	39	SAN JOAQUIN	6.61	5.96	7.41	7.98	9.11	9.35	9.99	9.99	9.35	9.11	7.66	7.49
	50	STANISLAUS	6.95	6.32	7.38	8.01	9.17	9.17	9.80	9.80	9.17	9.06	7.69	7.48
	54	TULARE	7.14	6.44	7.53	8.07	9.00	9.23	9.62	9.62	9.00	9.00	7.84	7.53